TIME DOMAIN ELECTROMAGNETIC SURVEY FOR ASSISTING IN DETERMINING THE GROUNDWATER RESOURCES ON PROPERTY LOCATED IN THE KAU DISTRICT ISLAND OF HAWAII

Project Number 5128

August 2008

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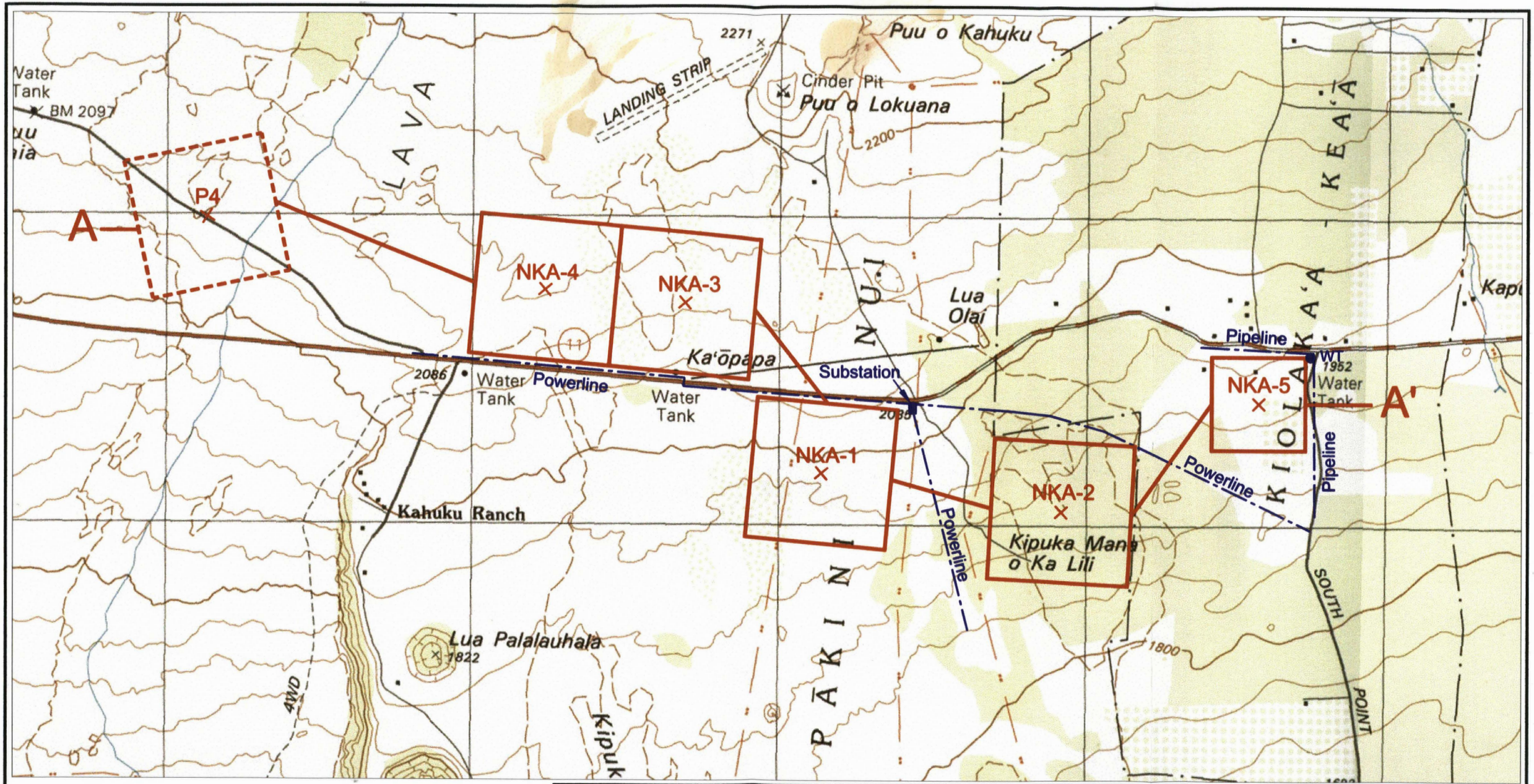
1.0 INTRODUCTION

This report contains the procedures and results of a surface Time Domain Electromagnetic (TDEM) geophysical survey performed for groundwater resource evaluation on property located near Kahuku Ranch in the Kau District, Island of Hawaii. Zapata Incorporated, Blackhawk Division (Blackhawk) conducted the survey from August 5 through August 9, 2007 for Nani Kahuku Aina, LLC (NKA) located in Aiea, Hawaii.

The main objective of the TDEM survey was to explore for high-level groundwater occurrences on property that NKA has gained access permission. The survey was conducted at five TDEM sites to help determine the optimum location for a future groundwater well located along Mamalahoa Highway (Hwy 11) near the junction of South Point Road. Figure 1-1 shows the locations of TDEM soundings taken during the present 2008 survey and in a 1990 survey conducted along the highway.

TDEM is a geophysical method that determines from the surface the geoelectric section (resistivity layering) of the subsurface. From the geoelectric section, information about geology and water quality can be inferred. This is possible because the electrical resistivity of the earth depends on lithology, porosity, the degree of saturation, and concentration of dissolved solids in the groundwater. Geophysical surveys, combined with other hydrogeologic information, are used to provide optimum locations for well placement and well completion depths.



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Nani Kahuku Aina, LLC
Aiea, Hawaii

Geophysical TDEM Survey
TDEM Location Map
Kau District
Island of Hawaii

Project No:	Date:	Drawn By:	Checked By:	Scale:	Figure:
5128	August, 2008	HJV	RJB	1"=1000'	1-1

2.0 GEOLOGY/HYDROGEOLOGY

Groundwater resources occur on the Hawaiian Islands basically in two modes:

- In a basal mode where a lens of fresh water floats on seawater, and
- In a high-level mode where the fresh groundwater occurrence is controlled by damming structures (i.e. intrusives, dikes, etc).

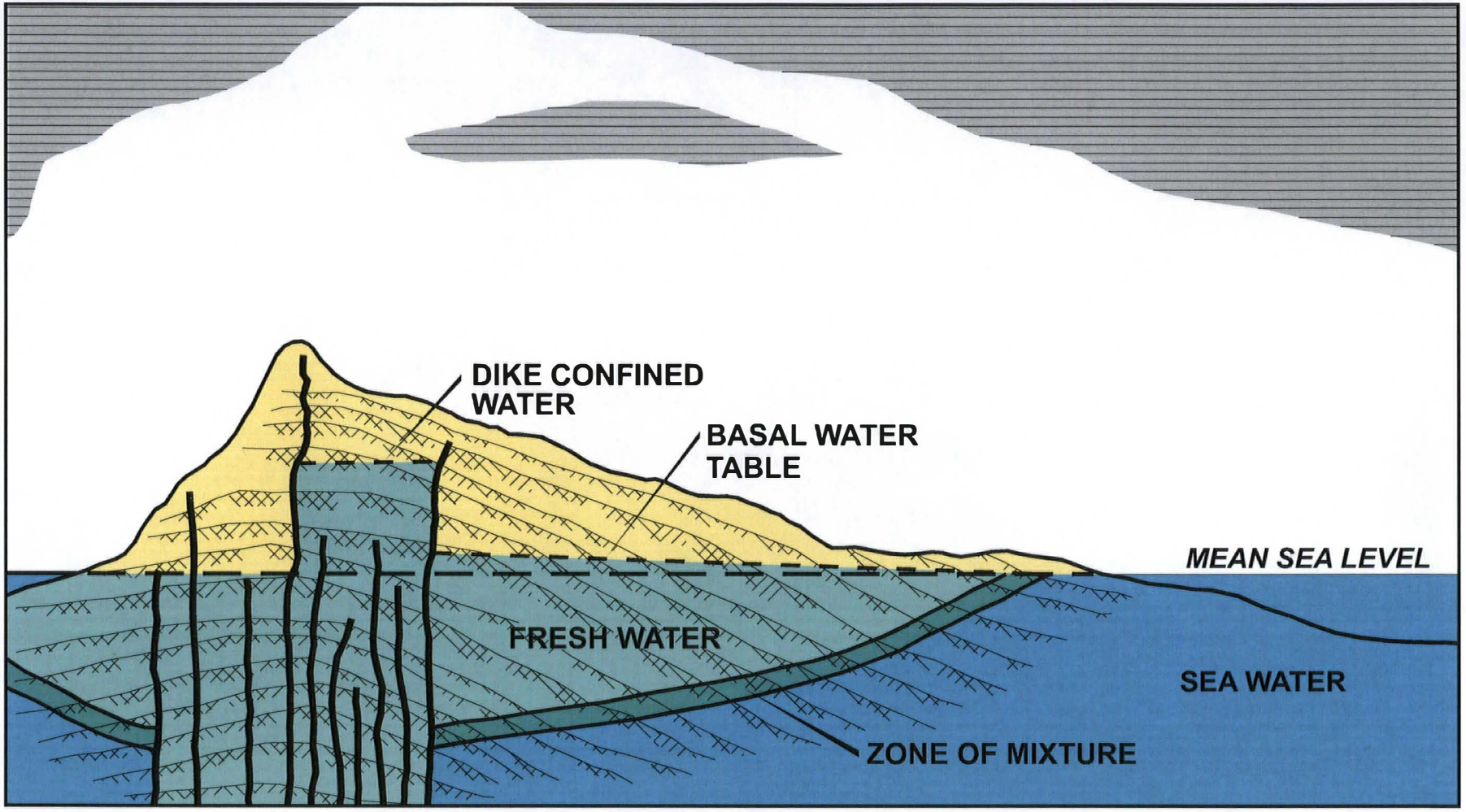
The basic geologic and hydrologic framework of the Island of Hawaii and the two modes of groundwater occurrences are illustrated in Figure 2-1. Fresh groundwater may also occur in areas between these two modes, but production is expected to be highly variable. TDEM surveys previously run on Hawaii have reliably mapped basal mode groundwater and the boundary between fresh water in the basal mode and high-level water occurrences.

Basal mode groundwater is resting approximately at sea level near the ocean surrounding the Island of Hawaii. This is generally due to the fact that the volcanic rocks, which comprise the island, allow rainfall to percolate with little impedance directly downward through the rock mass (reference Figure 2-1). The fresh water floats directly on seawater encroaching from the ocean. Fresh water flows laterally toward the ocean causing the fresh water lens to be thinner near the shore line. When groundwater is under conditions of static equilibrium, the Ghyben-Herzberg Principle states that for every one foot of fresh water above sea level, approximately 40 feet of fresh water will exist below sea level as shown in Figure 2-2. The change from fresh water to seawater (transition zone) at depth may be relatively sharp (i.e. occurring over several tens of feet) or more gradual, depending upon hydrologic flux, horizontal and vertical permeability contrast, and other geologic factors. It is assumed, when resolving TDEM sounding data, that seawater saturated volcanics begin at the midpoint of the transition zone.

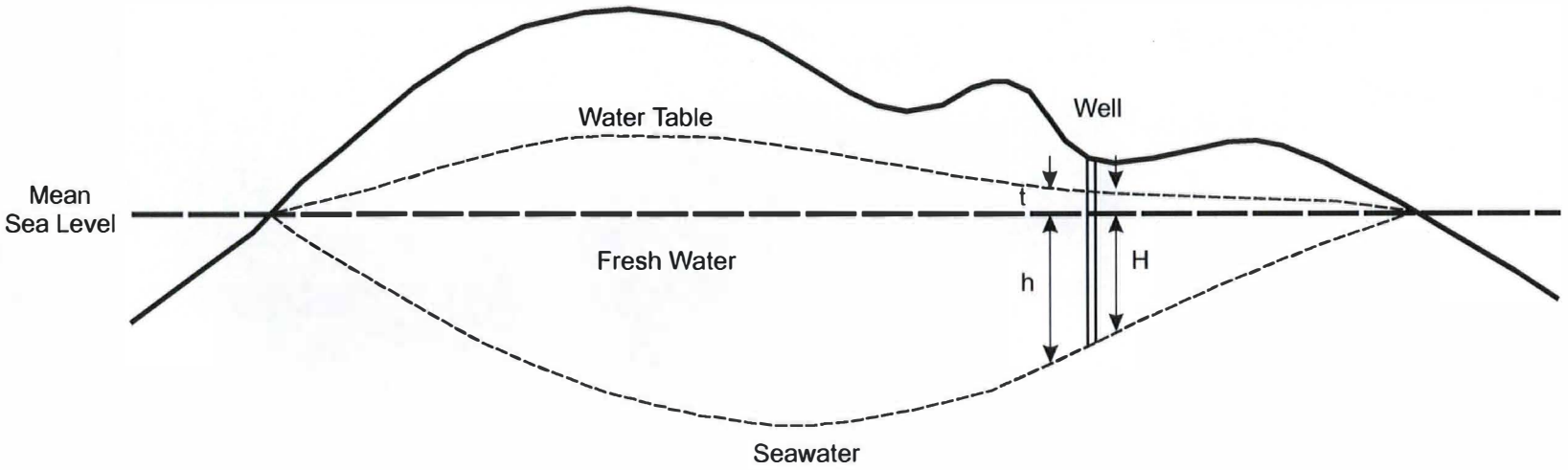
TDEM surveys are utilized to map the resistivity stratification of the subsurface. From numerous previous TDEM surveys and calibration at groundwater wells, characteristic ranges of subsurface resistivities have been derived for the geologic/hydrologic units shown in Figure 2-3. Some overlap in resistivity occurs between the units; however, other factors (such as elevation) can be used to help separate the units. Therefore the main geologic/hydrologic units that can be derived from TDEM surveys are:

- Depth to seawater saturated volcanic rocks. This occurs in basal mode situations, and by using the Ghyben-Herzberg Principle, the thickness of the basal fresh water lens can be calculated.
- Weathered volcanic layers (laterite). These lower resistivity units are generally relatively thin (100 ft to 200 ft thick) layers that occur mainly at or near the ground surface.
- Clay poor and fresh water saturated volcanic rocks. These formations generally exhibit high resistivity values. Note that the extent of fresh water saturation is normally based on geographic and elevation information, and that fresh water cannot usually be directly detected in the TDEM data.

Groundwater damming structures (i.e. intrusives, dikes) are inferred with TDEM data by uncharacteristic sounding curves (distorted by 2-D structures), and by soundings that transition between detection of seawater at depth (indicating basal mode groundwater) and soundings that map high resistivities to depths below sea level (indicating high-level groundwater). Figure 2-4 illustrates the geologic and topographic map with historic and prehistoric cinder cones, fissure vents and faults in the project area. Also shown on the map are the locations of the TDEM soundings taken during these surveys.



BLACKHAWK A DIVISION OF ZAPATA	Nani Kahuku Aina, LLC Aiea, Hawaii			Schematic Hydrogeologic Cross Section Island of Hawaii		
301 Commercial Road, Suite B Golden, Colorado 80401 Phone: (303) 278-8700 Fax: (303) 278-0789 Web: www.blackhawkgeo.com	Project No: 5128	Date: August, 2008	Drawn By: HJV	Checked By: RJB	Scale: No Scale	Figure: 2-1



$t = 1/40\ (h)$

BLACKHAWK A DIVISION OF ZAPATA	Nani Kahuku Aina, LLC Aiea, Hawaii	**Illustration of the Ghyben-Herzberg Principle**

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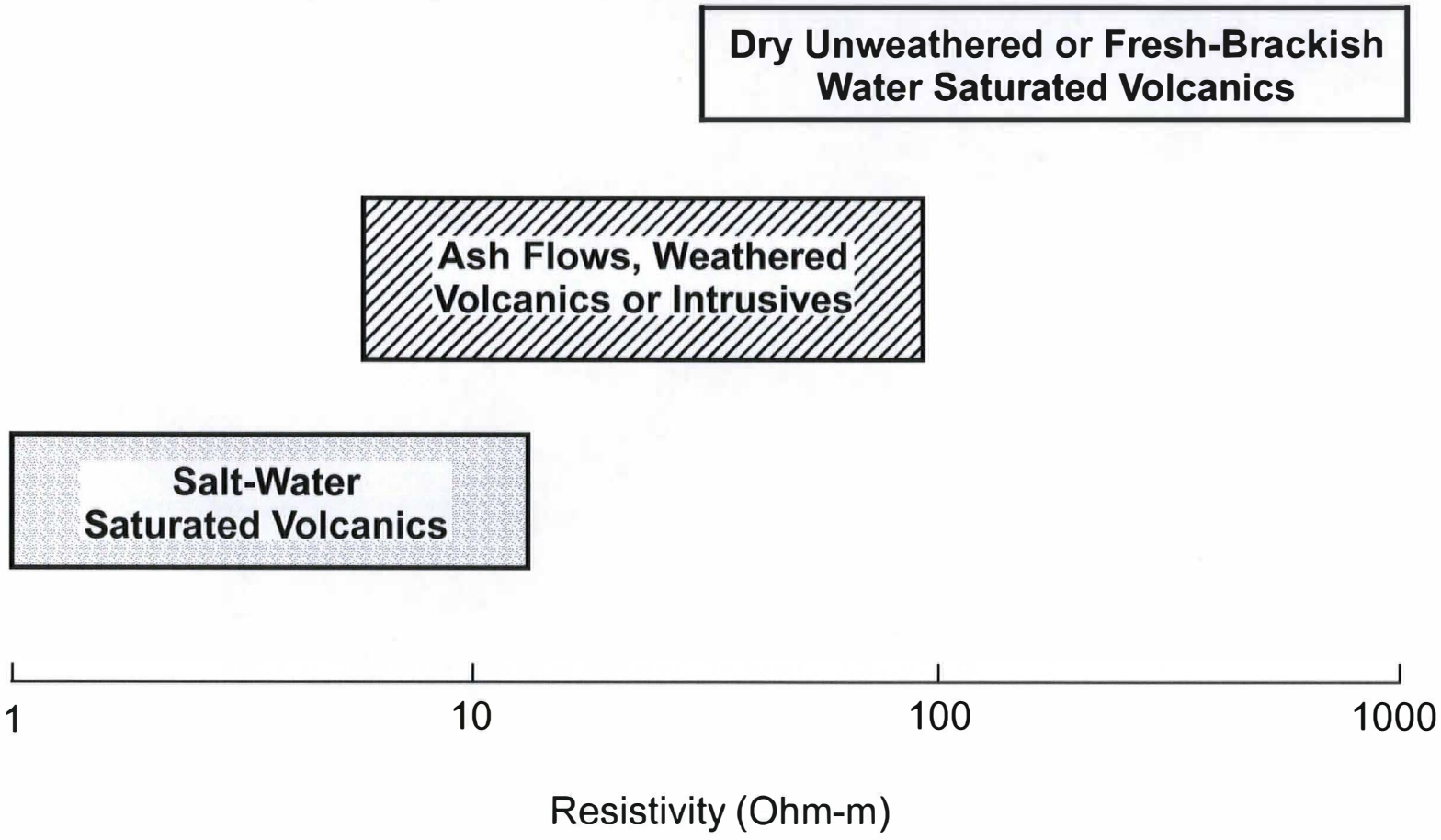
5128	August, 2008	HJV	RJB	No Scale	2-2



BLACKHAWK A DIVISION OF ZAPATA		Nani Kahuku Aina, LLC Aiea, Hawaii			**Characteristic Resistivity Ranges** *Island of Hawaii*		
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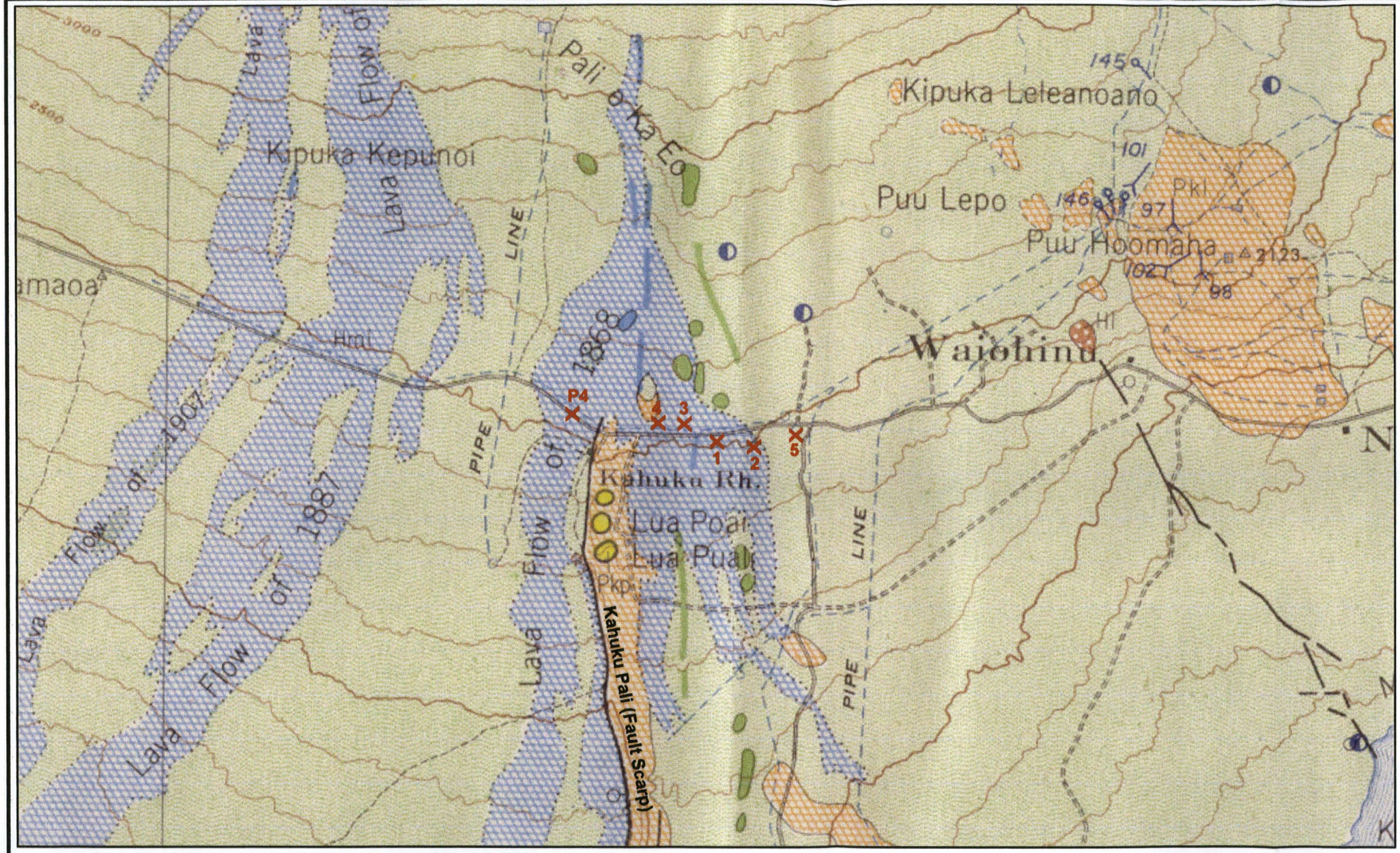


From: Geologic and Topographic Map of Island of Hawaii (USGS, B-9, 1946)

Symbols

- Quarry
- Strike and dip of beds
- Normal fault showing downthrown side, dashed where inferred
- Drilled well
- Dug well
- Maui-type well with vertical shaft
- Maui-type well with inclined shaft
- Water hole or ancient Hawaiian well
- Water-development tunnel described in text
- Spring
- Spring (See table in text)
- Aqueducts or Water Pipes

Explanation
Igneous Rocks
Mauna Loa

Kau volcanic series

HISTORIC MEMBER (1832 to 1942)

- Hml — *Basaltic lava flows.*
- Hmc — *Cinder and spatter cones and fissure vents at source of flows.*
- Hmcl — *Littoral cones formed where lava entered the sea.*
- Hmp — *Pit craters containing historic lava.*

PREHISTORIC MEMBER

- Qkl — *Basaltic lava flows.*
- Qkc — *Cinder and spatter cones and fissure vents at source of flows.*
- Qkcl — *Littoral cones formed where lava entered the sea.*
- Qkp — *Pit craters.*

KAHUKU VOLCANIC SERIES

- Pkl — *Basaltic lava flows, capped by Pahala ash and with intercalated ash beds.*
- Pkc — *Cinder and spatter cones at source of flows*
- Pkcl — *Littoral cone.*
- Pkp — *Pit crater.*

Contour Interval 250 Feet

Explanation

TDEM Sounding Location

N

0 5000 10,000

Scale in Feet

BLACKHAWK A DIVISION OF ZAPATA 301 Commercial Road, Suite B Golden, Colorado 80401 Phone: (303) 278-8700 Fax: (303) 278-0789 Web: www.blackhawkgeo.com	Nani Kahuku Aina, LLC Aiea, Hawaii			Geologic & Topographic Map *Kau District* *Island of Hawaii*		
	Project No: 5128	Date: August, 2008	Drawn By: HJV	Checked By: RJB	Scale: As Shown	Figure: 2-4

3.0 DATA ACQUISITION AND LOGISTICS

Blackhawk mobilized a field crew consisting of a project geophysicist and geophysical technician to perform the geophysical survey on the property located along the Mamalahoa Highway. The Blackhawk field personnel and TDEM equipment were mobilized from Golden, Colorado to Kailua-Kona, Hawaii. Prior to conducting the survey, NKA personnel coordinated with local property owners and gained land access permission to the properties for the survey. Tom Nance (TNWRE) provided project direction and oversight during the fieldwork. A daily log of field activities during the TDEM surveys is presented in Table 3-1.

The geophysical equipment utilized for the TDEM survey was the Geonics EM37 system. The EM37 system contains both a portable motor-generator powered transmitter and a PROTEM digital receiver. The main purpose of the TDEM measurements is to derive both the vertical and lateral variations in the geoelectric section (resistivity) of the subsurface. To accomplish this, the TDEM soundings were collected using a central-loop array at each site. The square transmitter loops were constructed using 12-gauge insulated copper wire laid on the ground surface, as illustrated in Figure 3-1. The dimensions of the transmitter wire loops ranged from 1,000 ft by 1,000 ft to 1,500 ft by 1,500 ft. The motor-generator and transmitter were placed at a corner of each wire loop and square-wave current pulses were driven through the wire using a current ranging from 12 to 13 amperes. The current pulses induce eddy current flow in the subsurface of the ground. A receiver coil (1-meter diameter) attached to the PROTEM receiver was positioned in the center of each wire-loop and used to record the decay of the secondary magnetic field from eddy currents induced in the subsurface. The effective exploration depth using a 1,000 ft by 1,000 ft transmitter wire-loop array has been determined to be approximately 2,500 ft. Greater exploration depths are reached with larger wire loops and several factors that affect the depth of investigation include ground resistivity (ohm-m) and surrounding ambient cultural interference (i.e. 60-cycle powerline, pipelines, etc).

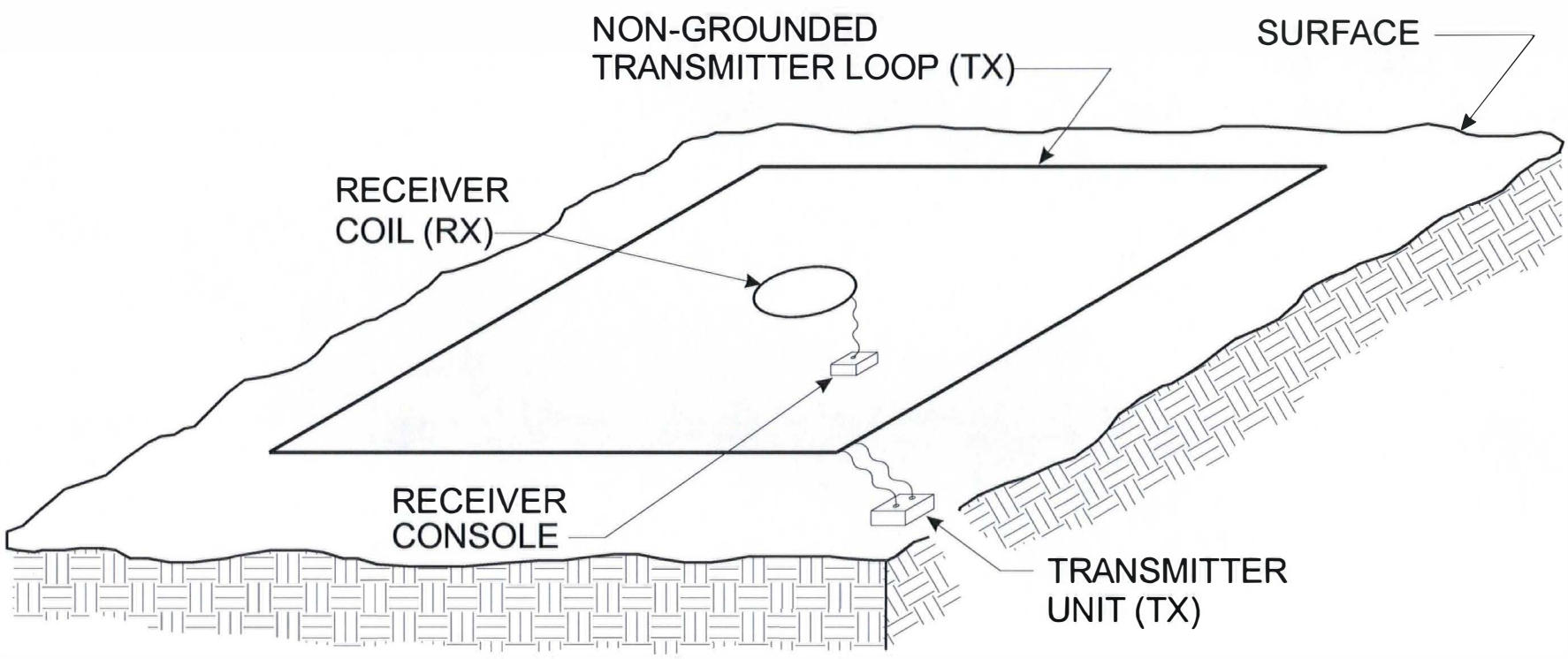
The TDEM data acquired at each sounding consisted of measurements utilizing several receiver gain settings and two transmitter frequencies in order to ensure data quality and to obtain data over the longest possible time interval. The data were recorded at base frequencies of 3 Hz and 30 Hz for each TDEM sounding. For data quality control (QC) purposes, additional offset data sets were collected at designated locations (normally 200 ft offset) from the center of each sounding for comparison to the central-loop data. The data from each sounding were stored in a solid-state memory logger in the PROTEM receiver and transferred at the end of each day to a PC for processing. The TDEM data collected with the PROTEM receiver were of excellent quality. However, Sounding 5 data was affected (distorted) by local cultural interference (i.e. pipeline, etc.), likely from a nearby underground metal pipeline along South Point Road. A technical note describing the principles of TDEM with case histories is given in Appendix A.

The corners of each transmitter wire-loop were registered to existing roads located on the ground surface. Other landmark features, such as rock walls, fences and water tanks were also used to position the corners of the wire-loops on the topographic map with a hip-chain and compass. In addition, a hand-held global positioning system (GPS) was utilized to locate both the center and

transmitter location (corner) of each sounding. The GPS coordinates were used to position each loop center onto the geo-referenced topographic map and the elevation was subsequently taken from that position. A total of five TDEM soundings were measured on the properties during the four days of fieldwork. The GPS coordinates and elevations of the TDEM sounding centers, water tanks and road junctions are given in Table 3-2 in Appendix B.

Table 3-1
Daily Log of Field Activities
NKA TDEM Survey

Date (2008)	Activity
July 29	Ship TDEM geophysical equipment from Golden, CO to Kailua-Kona, HI.
August 4	Mobilize Blackhawk field personnel from Golden, CO to Kailua-Kona, HI.
August 5	Unpack geophysical equipment at hotel and organize into 4WD vehicle. Test motor-generator, transmitter and PROTEM receiver. Drive to project site, perform reconnaissance of Loops 1 and 2 and attempt contact with landowners. Call client to discuss project.
August 6	Begin geophysical survey. Lay out wire-loop and collect TDEM data on Sounding NKA-1. Download data to PC and perform preliminary data analysis. Discuss results with TNWRE.
August 7	Contact client and meet with David Rudacille to discuss property access and loop location. Lay out and acquire data on Sounding NKA-2. Download data to PC and perform preliminary data analysis. Discuss results with TNWRE. Decision is made by TNWRE to collect data on Loop 3a (alternate location on north side of Hwy 11).
August 8	Call client and proceed with recon of alternate loop location. Lay out wire and collect data on Sounding NKA-3 (north side of Hwy 11). Download data and perform preliminary data analysis. Discuss results with TNWRE. Decision is made by TNWRE to collect data on Loop 4.
August 9	Lay out and take data on Sounding NKA-4. Pickup wire-loop and move to Floyd Pulham's property to discuss access and loop location. Collect data on Sounding NKA-5. Download data and perform data analysis. Discuss results with TNWRE. Finish project.
August 10	Day off.
August 11-12	Pack up TDEM equipment at hotel and deliver to FedEx office at airport. Demobilize Blackhawk personnel from Kailua-Kona, HI to Golden, CO.



BLACKHAWK A DIVISION OF ZAPATA		Nani Kahuku Aina, LLC Aiea, Hawaii			Schematic layout of TDEM system with locations of TX and RX for Central Loop Array measurements		
301 Commercial Road, Suite B Golden, Colorado 80401	Phone: (303) 278-8700 Fax: (303) 278-0789 Web: www.blackhawkgeo.com	Project No: 5128	Date: August, 2008	Drawn By: HJV	Checked By: RJB	Scale: No Scale	Figure: 3-1

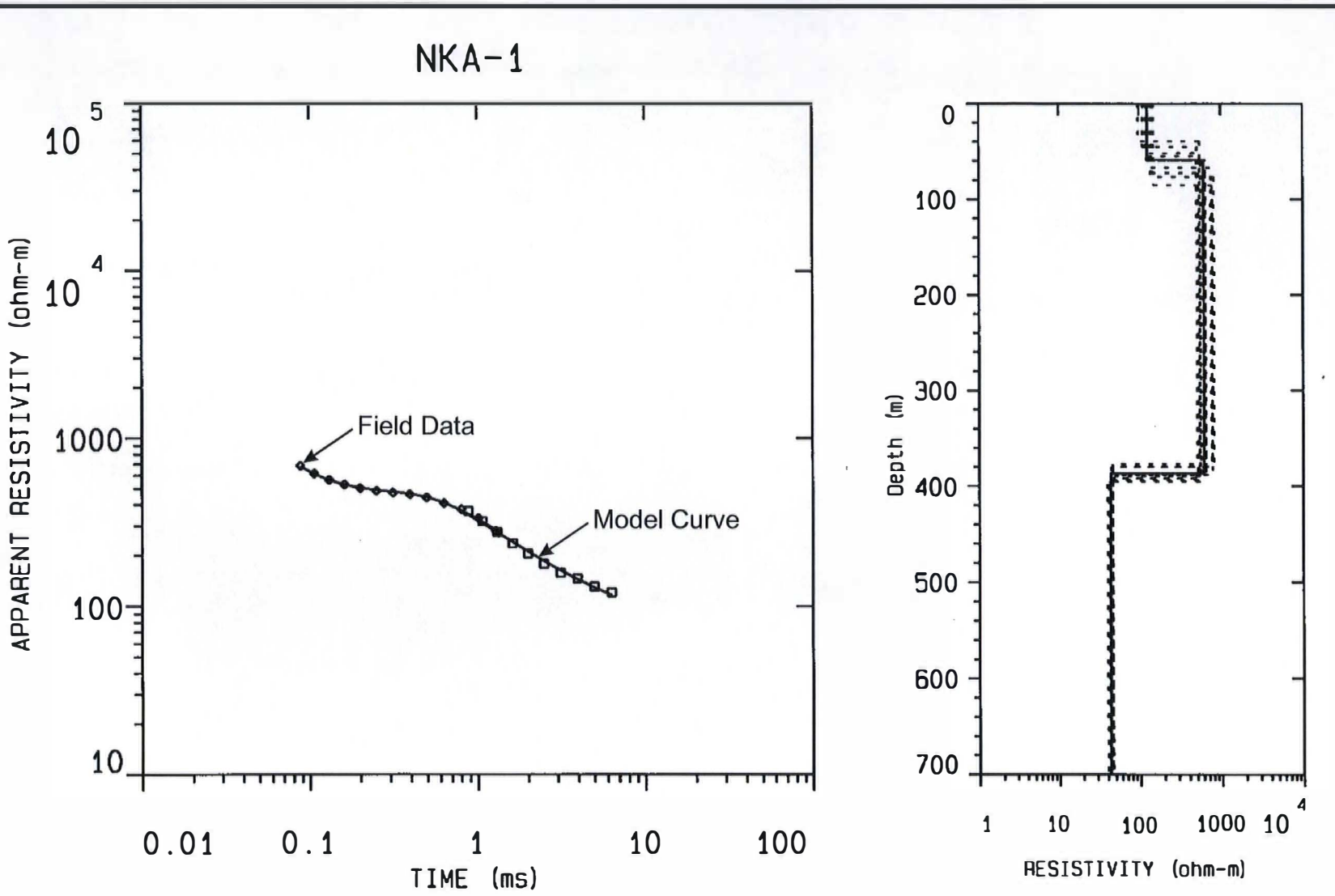
4.0 DATA PROCESSING

The field data collected for each TDEM sounding was transferred from the Geonics PROTEM digital receiver to a PC for editing and processing. Processing of the TDEM data begins with averaging of the electromotive forces recorded at positive and negative receiver polarities. Next, the measurements collected at the two base frequencies (3 and 30 Hz) and amplifier gains are combined to give one voltage decay curve (transient). The electromotive forces in the various time gates of the decay curves were subsequently entered into the TEMIXXL (Interpex Ltd) inversion program to obtain a one-dimensional (1-D) geoelectric section that best matches the observed decay curve.

The TEMIXXL inversion program requires an initial model of the geoelectric section measured. The initial model includes the number of layers, resistivities and thickness for each of the layers. This model is usually derived from knowledge of the geologic section or from data obtained from drill holes or electric logs. The inversion program is then allowed to adjust the layer thickness and the resistivities, so that the model curve converges to best fit the field data. The inversion program does not change the total number of layers within the model curve, but allows all other parameters to change freely or they can optionally be fixed constant. To determine the influence of the number of layers on the solution, separate inversions with a different number of layers are run. Subsequently, the model with the least number of layers that best fits the field data is used.

An example of the output of the inversion program is shown on Figure 4-1 for Sounding NKA-1. This figure shows the measured data points (in terms of apparent resistivity) superimposed on a solid line on the left panel. The solid line represents the computed forward model for the geoelectric section on the right panel. This geoelectric section is the best match obtained by the inversion program. Figure 4-2 shows the tabulated inversion parameters consisting of measured data, computed data for best match solutions and an example of the table of inversion statistics. A three-layer inversion model is shown for Sounding NKA-1. The model displays a relatively thin (193 ft) resistive (126 ohm-m) upper layer overlying a resistive (610 ohm-m) second layer. The third layer exhibits a moderate resistivity (44 ohm-m) and the depth to the top of the third layer is modeled at 712 ft above sea level (ASL) in the section.

The interpreted geoelectric section derived from each TDEM sounding is not unique. The magnitude of each individual layer resistivity and thickness can normally be varied within a limited range with no significant change to the fit of the geoelectric model of the data. This variation is termed equivalence. An equivalence analysis was performed for each TDEM sounding. Both Figures 4-1 and 4-2 also show the equivalence analysis for Sounding NKA-1. This sounding is typical of the TDEM data and shows a +/-10% equivalence in depth determinations and +/-10% in individual layer resistivities. The inversion results for each sounding of this project are given in Appendix B.



BLACKHAWK A DIVISION OF ZAPATA	Nani Kahuku Aina, LLC Aiea, Hawaii			Sounding NKA-1 Example Inversion Output Apparent Resistivity Curve *Kau District* *Island of Hawaii*		
301 Commercial Road, Suite B Golden, Colorado 80401 Phone: (303) 278-8700 Fax: (303) 278-0789 Web: www.blackhawkgeo.com	Project No: 5128	Date: August, 2008	Drawn By: HJV	Checked By: RJB	Scale: No Scale	Figure: 4-1

DATA SET: NKA-1

CLIENT: Nani Kahuku Aina, LLC — DATE: 08-06-08
LOCATION: Parcel 1 — SOUNDING: 1
COUNTY: Hawaii — ELEVATION: 603.50 m
PROJECT: Kau District, HI — EQUIPMENT: Geonics PROTEM
LOOP SIZE: 457.000 m by 457.000 m — AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) — TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 1.0000 N: 1.0000 — SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.240 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	(ft)	CONDUCTANCE (Siemens)
			603.5	1980.0	
1	125.6	58.89	544.6	1786.7	0.468
2	609.7	327.6	216.9	711.6	0.537
3	43.68				

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	97.307	125.633	151.066
	2	509.512	609.759	821.800
	3	40.017	43.685	46.685
THICK	1	39.096	58.896	85.189
	2	300.444	327.678	350.274
DEPTH	1	39.096	58.896	85.189
	2	376.927	386.574	395.161

Equivalence Analysis

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 6 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.881	263.8	286.4	-8.59
2	1.06	201.8	209.1	-3.65
3	1.31	150.5	151.3	-0.494
4	1.61	112.0	108.7	2.92
5	2.00	81.10	77.74	4.14
6	2.50	57.59	54.15	5.96
7	3.14	38.94	37.22	4.41
8	3.95	24.61	25.05	-1.78
9	4.99	16.36	16.61	-1.54
10	6.31	10.20	10.79	-5.77

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
11	0.0881	33101.7	33599.2	-1.50
12	0.106	23995.4	24153.9	-0.660
13	0.131	16337.9	16405.4	-0.413
14	0.161	10651.1	10673.4	-0.208
15	0.200	6696.0	6664.4	0.472
16	0.250	4052.9	3999.5	1.31
17	0.314	2392.3	2344.5	1.99
18	0.395	1392.3	1377.4	1.07
19	0.499	829.3	821.7	0.917
20	0.631	518.9	512.6	1.22
21	0.799	325.4	333.3	-2.43
22	1.01	216.0	221.3	-2.44
23	1.28	154.6	150.6	2.57

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.86				
P 2	-0.06	0.49			
P 3	0.01	-0.07	0.93		
T 1	-0.22	-0.29	0.00	0.56	
T 2	0.04	0.11	0.02	0.09	0.97

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Nani Kahuku Aina, LLC
Aiea, Hawaii

Sounding NKA-1
Example of Tabulated Data
From Inversion
Kau District
Island of Hawaii

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5128	August, 2008	HJV	RJB	No Scale	4-2

5.0 INTERPRETATION AND RESULTS

5.1 TDEM SOUNDING DATA

From each TDEM sounding, the geoelectric section of the subsurface is derived. The results of the one-dimensional (1-D) inversion of the individual TDEM soundings can be linked together (layers with similar resistivities) to create a 2-D geoelectric cross-section along a survey line. A total of five (5) TDEM soundings were collected on property along Mamalahoa Highway (reference Figure 1-2). From the TDEM survey data a single geoelectric cross-section was generated. The correlations between geoelectric layers and lithologic units, presented on Figure 2-3, were used to interpret the geoelectric cross-section.

5.2 GEOELECTRIC CROSS-SECTION – LINE 1 (A-A')

Figure 5-1 shows the layered geoelectric cross-section interpreted from TDEM data collected along Line 1. The TDEM soundings were located on both the north and south sides of Mamalahoa Highway (Hwy 11) in a roughly west to east direction in this area. Soundings NKA-3 and 4 were situated on the north side of Hwy 11. Sounding NKA-5 was positioned southwest of the water tank located at the junction of Mamalahoa Highway and South Point Road and the data was determined to be distorted by cultural interferences (i.e. metal pipelines) located along the roads. Sounding NKA-5 is shown on the cross-section and labeled as distorted and the geoelectric section model for this sounding was not used in the overall interpretation.

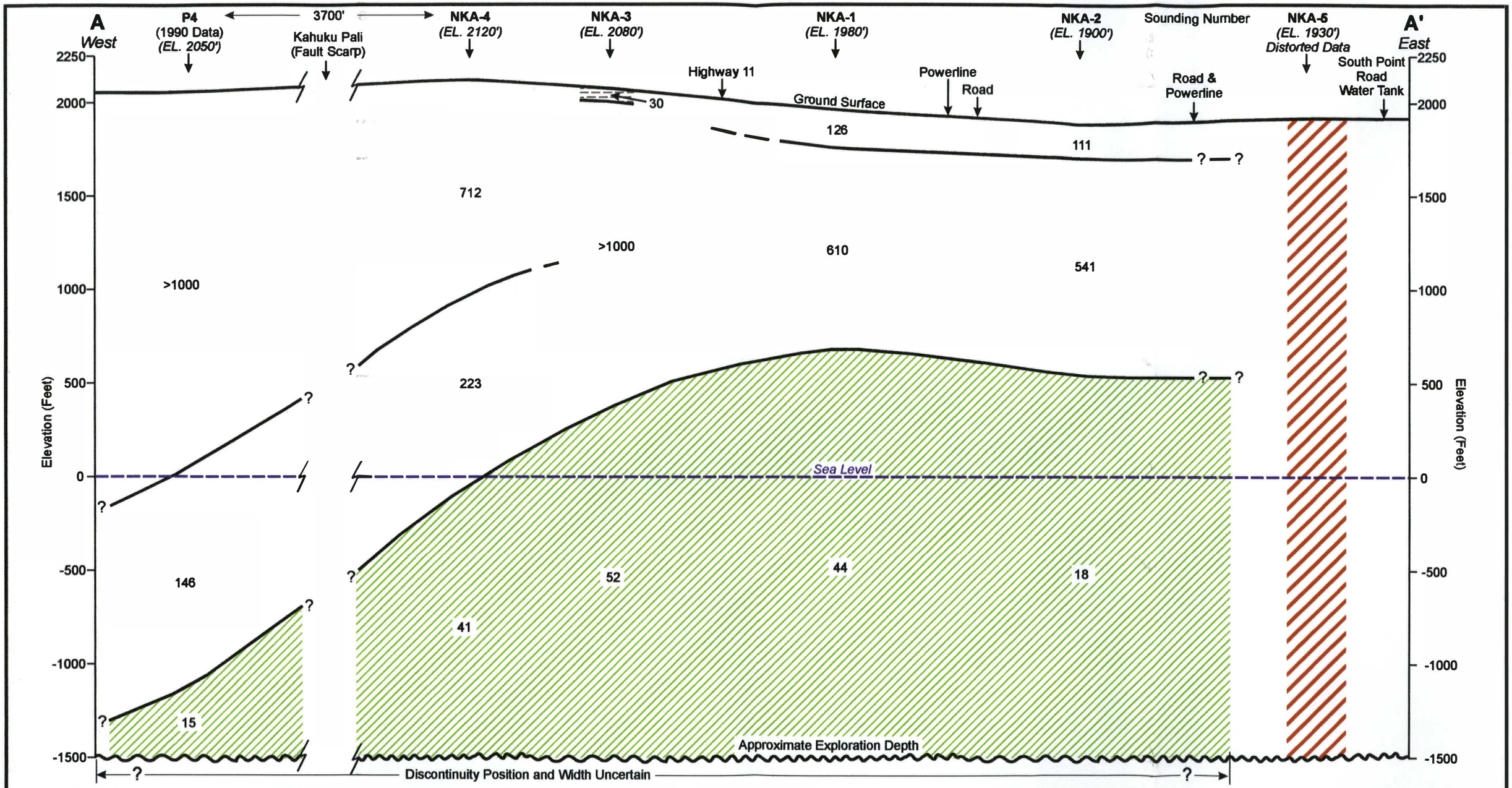
This cross-section includes data from Soundings NKA-1 through NKA-4 taken during the present survey along with Sounding P4 taken in 1990. A three-layer cross-section is interpreted for all the soundings along the survey line. The upper layer beneath Sounding NKA-3 exhibits low resistivity (30 ohm-m) and is interpreted to be a thin (57 ft) clay rich laterite surface layer. The remaining upper two layers in the geoelectric cross-section exhibit high resistivities that range from 146 to >1,000 ohm-m and are interpreted as dry, clay poor volcanic formations both above and below sea level. Where this layer occurs below sea level (Sounding P4), it is expected to be saturated with fresh-brackish basal mode water.

The third layer in the section with intermediate resistivities (15 to 52 ohm-m) is interpreted to represent volcanic layers containing clays or brackish water. At other locations in Hawaii, the presence of intermediate resistivity layers extending both above and below sea level often indicates a distortion of the TDEM data by high angle geologic features (i.e. faults, dikes, etc.). These geologic features often occur in the transition zone between basal groundwater and high-level groundwater. The TDEM soundings are interpreted assuming that the changes in the subsurface geoelectric/geologic section occur only in the vertical direction (horizontal layering in the immediate area beneath the sounding). It is expected that non-layered earth conditions (high angle 2-D geologic features) may exist in this area that are possibly acting as damming structures to groundwater. As shown on the geologic map (see Figure 2-4), fissure vents and faults occur in these areas which are likely causing damming to subsurface groundwater flow in this region. Therefore, the resistivity range of the lower layer indicates a geologic section consisting of either clay rich material or porous volcanics saturated with brackish groundwater.

A groundwater well located next to the water tank at the junction of Hwy 11 and South Point Road is reported to contain high-level water by a local land owner (per com Floyd Pulham). However, information regarding the static water level in the well was not available during this survey. As discussed above, TDEM data collected near this well was determined to be distorted by subsurface metal pipelines and this information could not be confirmed.

5.3 HYDROGEOLOGIC INTERPRETATIONS

The TDEM data from the survey is further summarized on the interpretation map shown in Figure 5-2. On this map all the soundings (green) exhibit intermediate resistivities (15 to 52 ohm-m) at the maximum search depth and they are likely influenced by high angle 2-D geologic features (i.e. faults, dikes, etc.) resulting in thick clay rich volcanic layers extending both above and below sea level. These soundings may also be located within the transition zone between basal and high-level groundwater. Due to the limited TDEM data in this area, the exact position and width of the geologic structure is uncertain in this region of the site.



Explanation

- 15 — Resistivity (Ohm-m)
- Resistivity Boundary (Dashed Where Uncertain)
- Inferred Lateral Discontinuity
- Laterite Soil (Clay Rich Layer)
- Dry Clay Poor or Fresh-Brackish Water Saturated Volcanics
- Inferred Structure (Possible Ash Falls, Weathered Volcanics or Intrusives)
- Sea Water Saturated Volcanics
- Distorted Sounding

Scale in Feet (Horizontal 2:1 Exaggeration): 500 / 0 / 1000

BLACKHAWK
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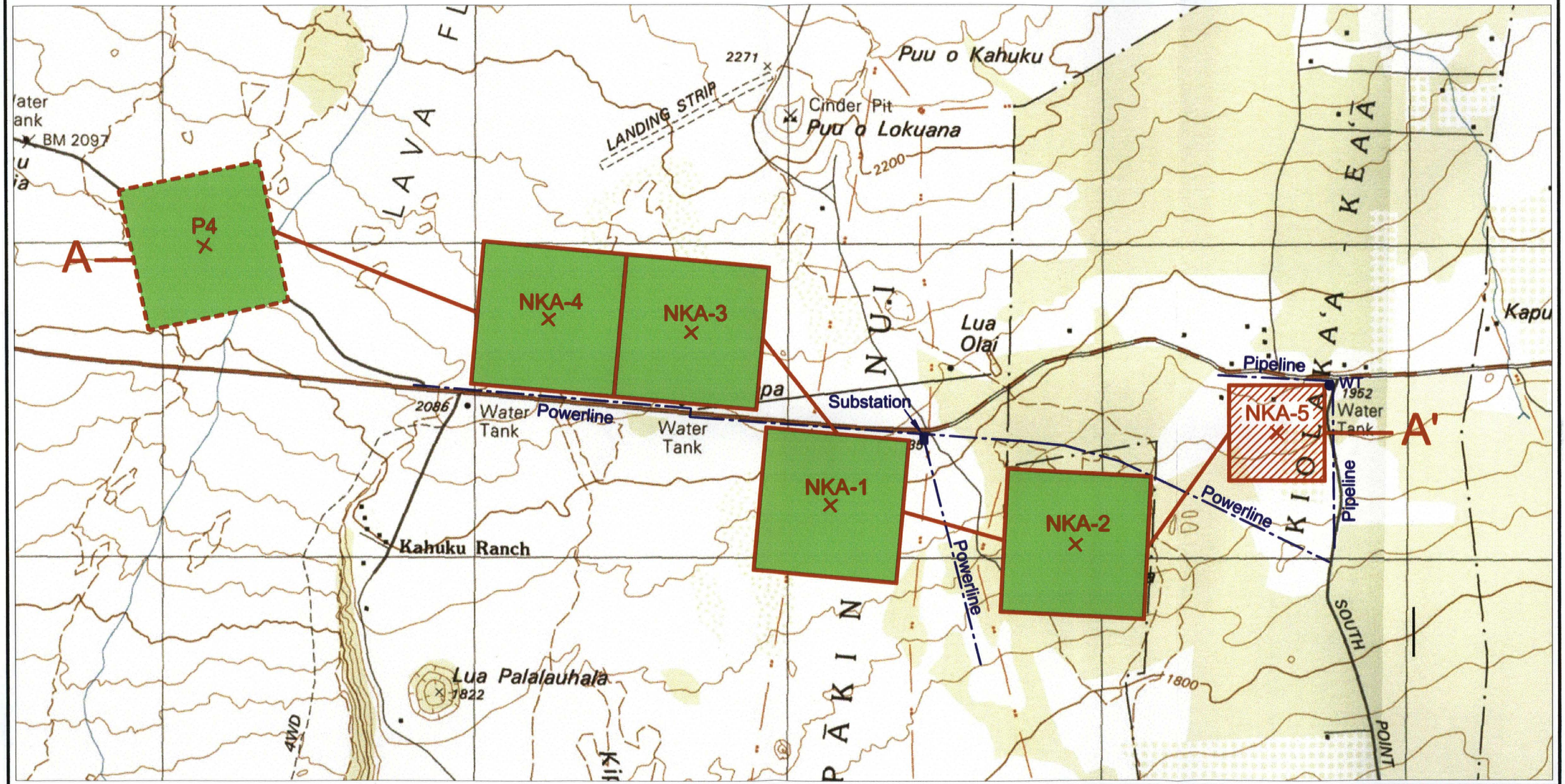
Nani Kahuku Aina, LLC
Aiea, Hawaii

Geoelectric Cross-Section from 1-D TDEM Inversions
Line 1 - Transect A-A'
Kau District
Island of Hawaii

Project No:	Date:	Drawn By:	Checked By:	Scale:	Figure:
5128	August, 2008	HJV	RJB	As Shown	5-1



Explanation

- NKA-1 — 2008 TDEM Sounding
- P4 — 1990 TDEM Sounding
- A-A' — Section Line
- WT — Water Tank
- Sounding Interpreted to be located within the Groundwater Barrier Data may be distorted by 2-D Geologic Structures
- Distorted Data

Hawaiian Islands

N

0 1000 2000
Scale in Feet

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Nani Kahuku Aina, LLC
Aiea, Hawaii

Geophysical TDEM Survey Summary Interpretation Map

Kau District
Island of Hawaii

Project No:	Date:	Drawn By:	Checked By:	Scale:	Figure:
5128	August, 2008	HJV	RJB	1"=1000'	5-2

6.0 CONCLUSIONS AND RECOMMENDATIONS

The main objective of the TDEM survey was to explore for high-level groundwater resources along Mamalahoa Highway (Hwy 11) mainly between Kahuku Ranch Road and South Point Road on the Island of Hawaii. The optimum location for high-level groundwater is expected to occur where high resistivity values (>400 ohm-m) are detected to the maximum search depth of the TDEM sounding (approximately 1,500 ft below sea level).

The results from the TDEM surveys are shown on Figures 5-1 and Figure 5-2. The general conclusions from the results are that:

- None of the soundings indicate the presence of high-level groundwater.
- All of the soundings are likely located within a structurally complicated transition zone between basal and high-level groundwater. It is possible that steeply dipping structures (i.e. fissure vents, faults, etc.) are influencing groundwater flow and distorting the TDEM soundings located near the structures. The hydrologic regime in these areas is complex and groundwater yield is expected to be highly variable.

The regions with potential fresh water resources in the survey area are interpreted to occur beneath Soundings NKA-4 and P4. Sounding NKA-4 is located in an area on the east side of the mapped Kahuku Fault. This sounding detected high resistivity (223 ohm-m) to a depth of sea level (reference Figure 5-1) and fresh water may be located within this zone (ground surface to sea level) and may be diverted at depth on the west by the Kahuku Fault. Sounding P4 detected high resistivity (146 ohm-m) to a depth of 1,100 ft below sea level and this region (sea level to -1,100 ft) may contain fresh-brackish groundwater. This sounding is located on the western side of the Kahuku Fault, and shows a distinct difference at depth from Sounding NKA-4.

Because of the limited TDEM data in this area, the optimum location (lowest elevation) for a high-level groundwater well was not determined. It is expected that high-level groundwater is located in the well near the South Point Road water tank. However, the present data did not confirm or deny this. Therefore, additional TDEM soundings placed above Mamaloahoa Highway in the area of the water well will help define the extent of the groundwater damming structures and location of potential high-level groundwater in this area of the property.

7.0 CERTIFICATION AND DISCLAIMER

All geophysical data analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by Zapata Incorporated, Blackhawk Division, Senior Geophysicists and Engineers.

This geophysical investigation was conducted using sound scientific principles and state-of-the-art technology. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing, interpretation, and reporting. All original field data files, field notes and observations, and other pertinent information are maintained in the project files and are available for the client to review.

A geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations, or ordinances.

Jim Hild

Manager/Senior Geophysicist
ZAPATA INCORPORATED
Blackhawk Division

Richard Blohm

Senior Geologist/Geophysicist
ZAPATA INCORPORATED
Blackhawk Division

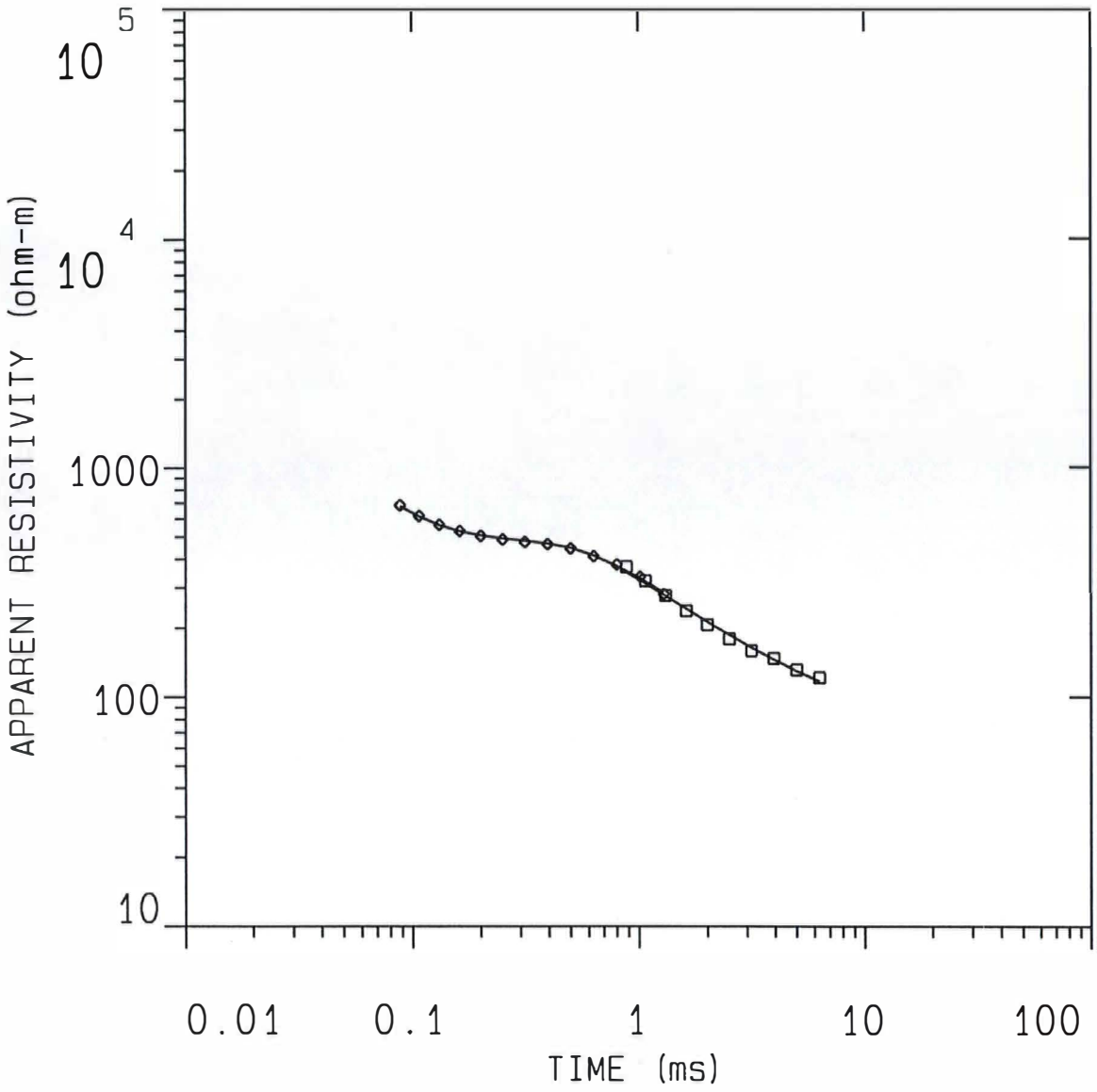
APPENDIX B

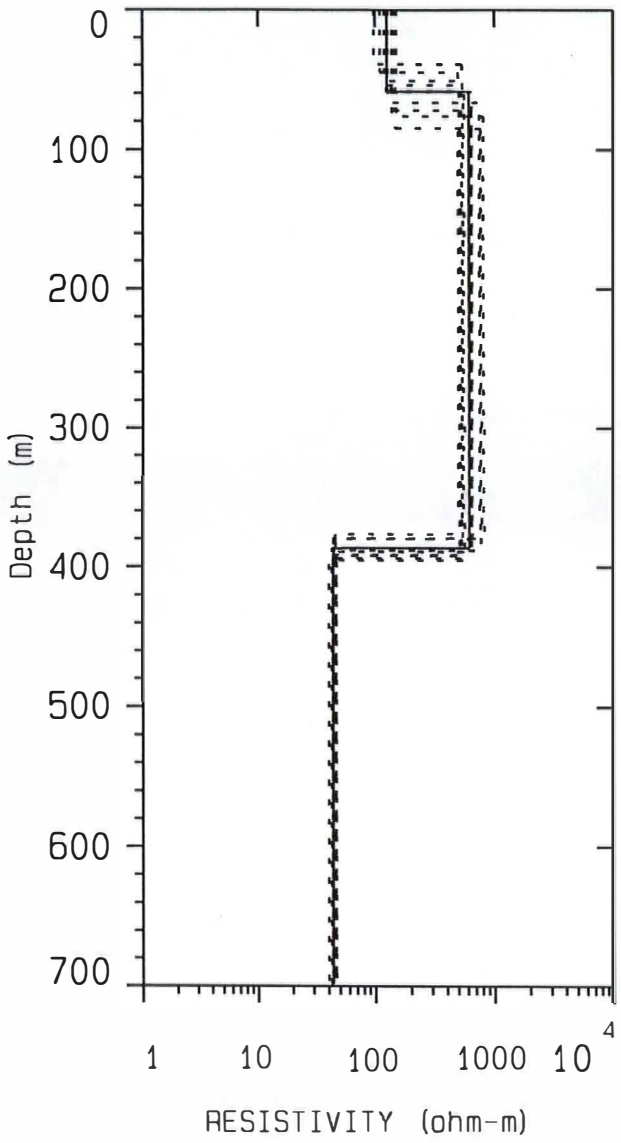
SOUNDING CURVES, DATA PRINTOUTS AND GPS COORDINATES FOR TDEM SOUNDINGS

Blackhawk Project Number: 5128

Prepared For:
NANI KAHUKU AINA

NKA-1


APPARENT RESISTIVITY (ohm-m)
10^5
10^4
1000
100
10
0.01
0.1
1
10
100
TIME (ms)


Depth (m)
0
100
200
300
400
500
600
700
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

DATA SET: NKA-1

CLIENT: Nani Kahuku Aina, LLC
LOCATION: Parcel 1
COUNTY: Hawaii
PROJECT: Kau District, HI
LOOP SIZE: 457.000 m by 457.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 1.0000 N: 1.0000

DATE: 08-06-08
SOUNDING: 1
ELEVATION: 603.50 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.240 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	(FT)	CONDUCTANCE (Siemens)
			603.5	1980.0	
1	125.6	58.89	544.6	1786.7	0.468
2	609.7	327.6	216.9	711.6	0.537
3	43.68				

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	97.307	125.633	151.066
	2	509.512	609.759	821.800
	3	40.017	43.685	46.685
THICK	1	39.096	58.896	85.189
	2	300.444	327.678	350.274
DEPTH	1	39.096	58.896	85.189
	2	376.927	386.574	395.161

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 6 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)

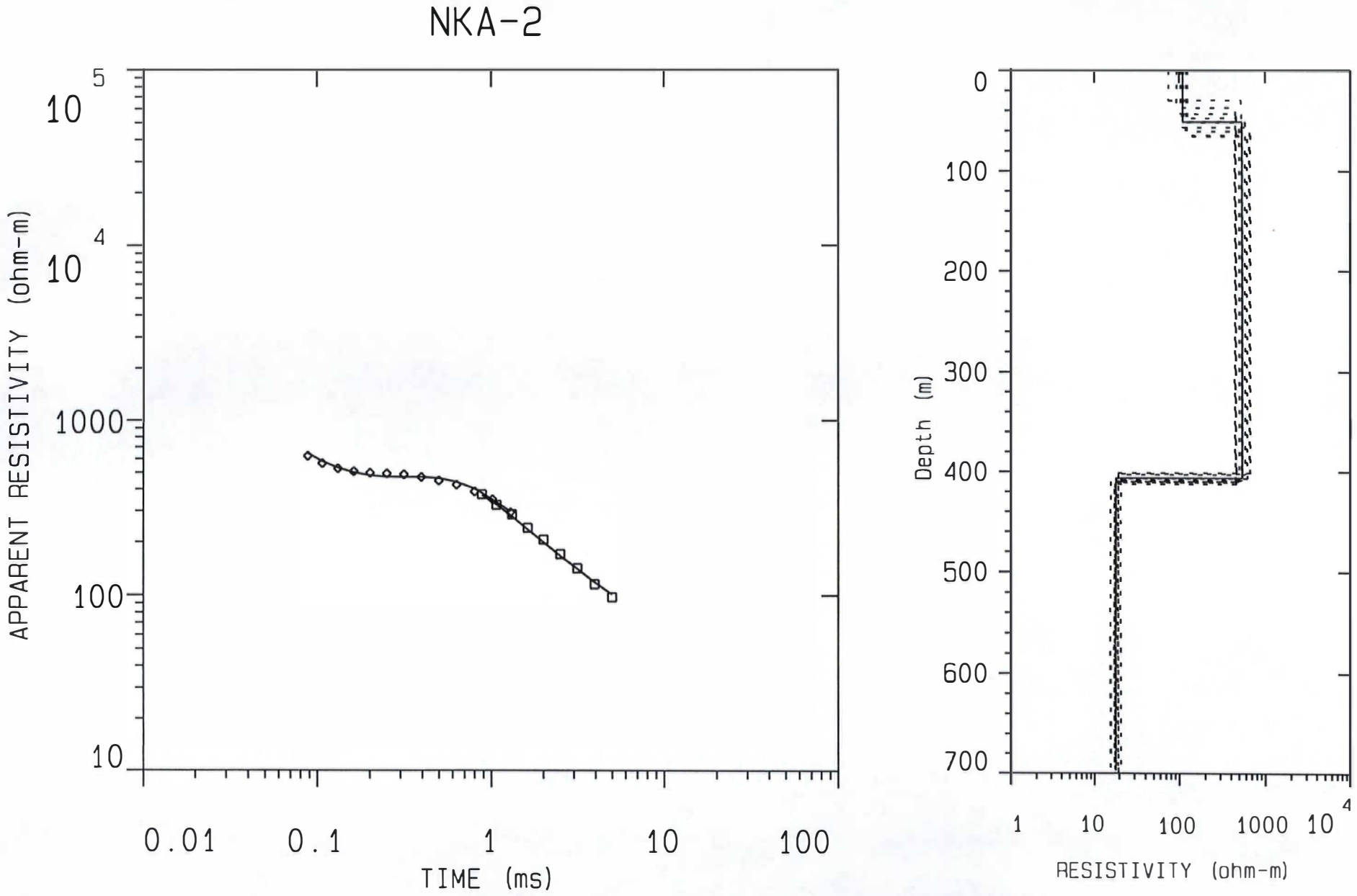
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.881	263.8	286.4	-8.59
2	1.06	201.8	209.1	-3.65
3	1.31	150.5	151.3	-0.494
4	1.61	112.0	108.7	2.92
5	2.00	81.10	77.74	4.14
6	2.50	57.59	54.15	5.96
7	3.14	38.94	37.22	4.41
8	3.95	24.61	25.05	-1.78
9	4.99	16.36	16.61	-1.54
10	6.31	10.20	10.79	-5.77

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
11	0.0881	33101.7	33599.2	-1.50
12	0.106	23995.4	24153.9	-0.660
13	0.131	16337.9	16405.4	-0.413
14	0.161	10651.1	10673.4	-0.208
15	0.200	6696.0	6664.4	0.472
16	0.250	4052.9	3999.5	1.31
17	0.314	2392.3	2344.5	1.99
18	0.395	1392.3	1377.4	1.07
19	0.499	829.3	821.7	0.917
20	0.631	518.9	512.6	1.22
21	0.799	325.4	333.3	-2.43
22	1.01	216.0	221.3	-2.44
23	1.28	154.6	150.6	2.57

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.86				
P 2	-0.06	0.49			
P 3	0.01	-0.07	0.93		
T 1	-0.22	-0.29	0.00	0.56	
T 2	0.04	0.11	0.02	0.09	0.97
	P 1	P 2	P 3	T 1	T 2


NKA-2
APPARENT RESISTIVITY (ohm-m)
10^5
10^4
1000
100
10
0.01
0.1
1
10
100
TIME (ms)
Depth (m)
0
100
200
300
400
500
600
700
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

DATA SET: NKA-2

CLIENT: Nani Kahuku Ania, LLC DATE: 08-07-08
LOCATION: David Rudacille Parcel SOUNDING: 2
COUNTY: Hawaii ELEVATION: 579.00 m
PROJECT: Kau District, HI EQUIPMENT: Geonics PROTEM
LOOP SIZE: 457.000 m by 457.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 2.0000 N: 1.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.094 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	(FT)	CONDUCTANCE (Siemens)
			579.0	1900.0	
1	110.8	51.17	527.8	1731.6	0.461
2	541.3	355.0	172.8	566.9	0.655
3	18.15				

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	75.310	110.828	125.781
	2	452.015	541.389	677.297
	3	15.730	18.151	20.944
THICK	1	29.802	51.176	65.468
	2	336.442	355.015	379.005
DEPTH	1	29.802	51.176	65.468
	2	400.988	406.192	412.323

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)

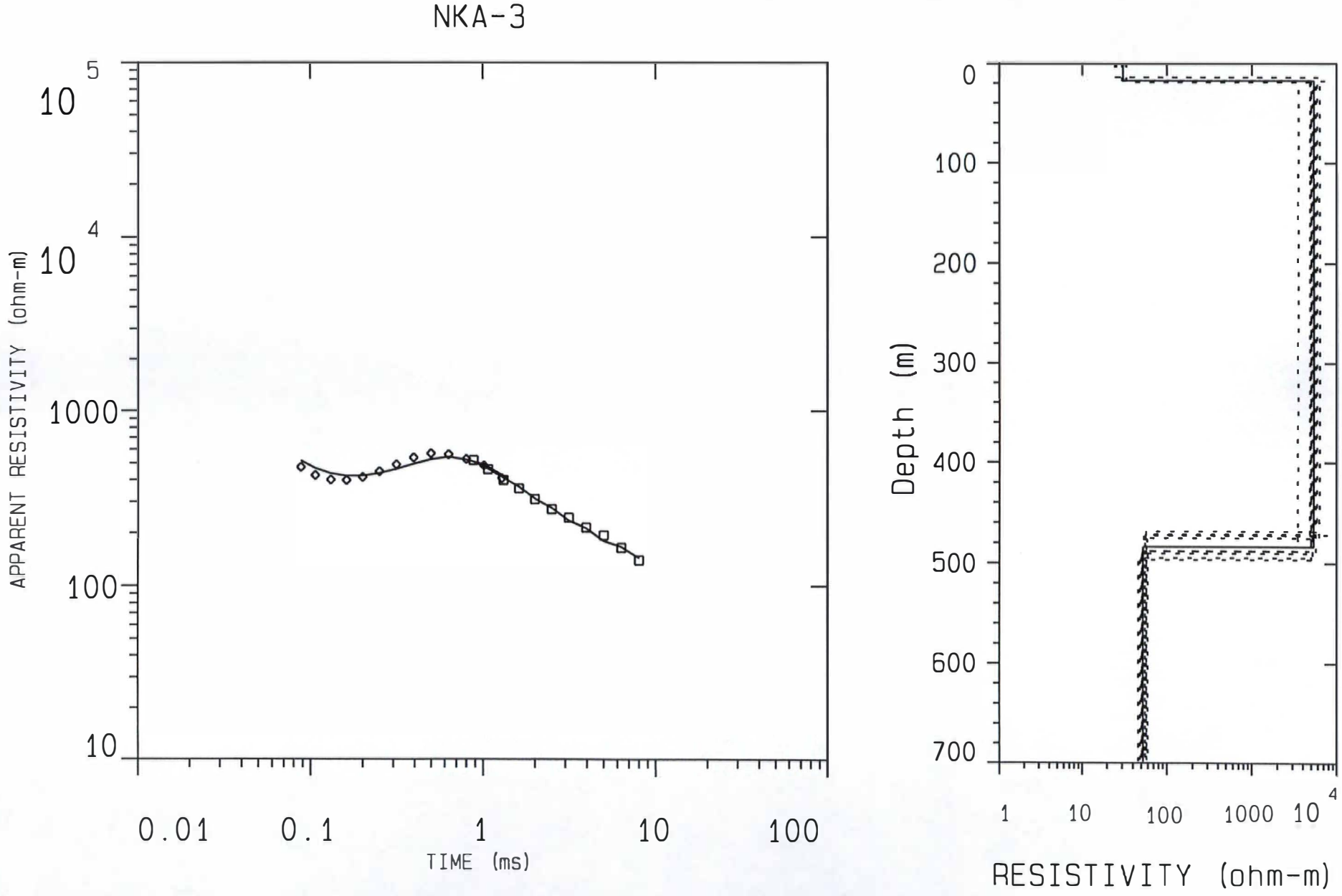
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.881	259.0	262.1	-1.16
2	1.06	196.6	196.1	0.271
3	1.31	141.8	147.4	-3.90
4	1.61	109.4	112.8	-3.16
5	2.00	80.87	85.14	-5.27
6	2.50	61.62	63.81	-3.55
7	3.14	46.10	46.72	-1.34
8	3.95	35.17	33.97	3.42
9	4.99	25.41	24.02	5.49

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
10	0.0881	38142.8	36107.7	5.33
11	0.106	27211.9	26083.9	4.14
12	0.131	18037.8	17736.3	1.67
13	0.161	11323.8	11522.3	-1.75
14	0.200	6815.7	7163.7	-5.10
15	0.250	3962.0	4222.5	-6.57
16	0.314	2287.6	2409.4	-5.32
17	0.395	1358.3	1354.7	0.262
18	0.499	814.1	773.2	5.03
19	0.631	491.9	464.2	5.63
20	0.799	311.9	294.0	5.72
21	1.01	201.3	202.0	-0.344
22	1.28	143.6	141.2	1.62

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.88				
P 2	-0.01	0.64			
P 3	0.02	-0.11	0.81		
T 1	-0.17	-0.18	-0.01	0.68	
T 2	0.02	0.05	0.01	0.05	0.99
	P 1	P 2	P 3	T 1	T 2


NKA-3
APPARENT RESISTIVITY (ohm-m)
10 5
10 4
1000
100
10
0.01
0.1
1
10
100
TIME (ms)
Depth (m)
0
100
200
300
400
500
600
700
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: NKA-3

CLIENT: Nani Kahuku Aina, LLC DATE: 08-08-08
LOCATION: National Park Land SOUNDING: 3
COUNTY: Hawaii ELEVATION: 634.00 m
PROJECT: Kau District, HI EQUIPMENT: Geonics PROTEM
LOOP SIZE: 457.000 m by 457.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 3.0000 N: 1.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 7.553 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	(ft)	CONDUCTANCE (Siemens)
			634.0	2080.0	
1	30.37	17.15	616.8	2023.6	0.564
2	5353.0	466.5	150.2	492.7	0.0871
3	52.47				

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	24.695	30.374	33.494
	2	3499.231	5353.083	16927.938
	3	46.239	52.479	59.562
THICK	1	14.095	17.159	18.933
	2	451.650	466.580	479.305
DEPTH	1	14.095	17.159	18.933
	2	468.616	483.740	496.626

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)

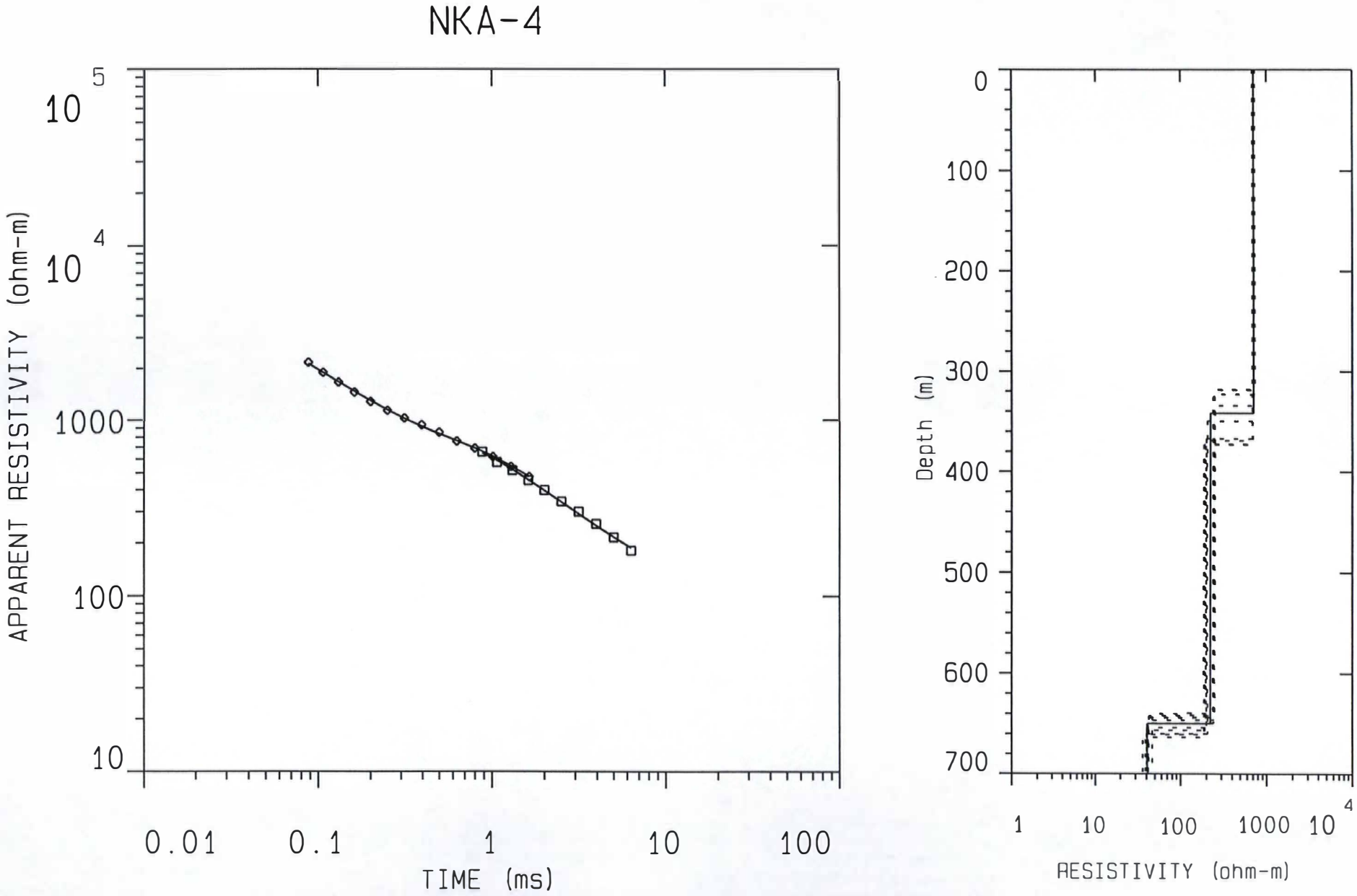
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.881	159.2	163.7	-2.78
2	1.06	117.3	116.2	0.879
3	1.31	86.80	82.98	4.39
4	1.61	60.78	58.73	3.37
5	2.00	43.88	43.54	0.775
6	2.50	30.65	29.95	2.29
7	3.14	20.52	21.70	-5.77
8	3.95	13.99	14.18	-1.34
9	4.99	9.07	10.15	-11.87
10	6.31	6.44	6.32	1.89
11	7.99	4.55	4.35	4.40

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
12	0.0881	57819.2	50788.0	12.16
13	0.106	41882.8	36445.0	12.98
14	0.131	27364.3	24159.1	11.71
15	0.161	16359.4	15032.5	8.11
16	0.200	9025.0	8758.4	2.95
17	0.250	4622.5	4785.9	-3.53
18	0.314	2280.5	2496.3	-9.46
19	0.395	1121.8	1269.3	-13.14
20	0.499	577.2	647.8	-12.22
21	0.631	327.5	343.5	-4.88
22	0.799	198.8	201.1	-1.15
23	1.01	124.5	121.7	2.24
24	1.28	88.03	82.84	5.89

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.97				
P 2	0.02	0.02			
P 3	0.01	-0.03	0.87		
T 1	-0.02	-0.02	0.01	0.97	
T 2	0.00	0.02	0.02	0.00	0.99


NKA-4
APPARENT RESISTIVITY (ohm-m)
10^5
10^4
1000
100
10
0.01
0.1
1
10
100
TIME (ms)
Depth (m)
0
100
200
300
400
500
600
700
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

DATA SET: NKA-4

CLIENT: Nani Kahuku Aina, LLC DATE: 08-09-08
LOCATION: National Park Land SOUNDING: 4
COUNTY: Hawaii ELEVATION: 646.00 m
PROJECT: Kau District, HI EQUIPMENT: Geonics PROTEM
LOOP SIZE: 457.000 m by 457.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 4.0000 N: 1.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 2.265 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	(ft)	CONDUCTANCE (Siemens)
			646.0	2120.0	
1	712.3	341.8	304.1	997.7	0.479
2	223.0	307.8	-3.70	-12.1	1.37
3	40.94				

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	691.090	712.397	733.336
	2	188.206	223.091	255.129
	3	36.213	40.941	46.507
THICK	1	318.399	341.896	373.158
	2	284.388	307.805	326.878
DEPTH	1	318.399	341.896	373.158
	2	639.452	649.700	663.305

CURRENT: 12.50 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 5 RAMP TIME: 200.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.881	106.8	108.9	-1.96
2	1.06	80.86	77.95	3.60
3	1.31	56.63	55.74	1.57
4	1.61	40.79	40.33	1.12
5	2.00	29.03	29.21	-0.619
6	2.50	20.85	21.06	-0.994
7	3.14	14.37	15.05	-4.76
8	3.95	10.29	10.65	-3.49
9	4.99	7.45	7.44	0.204
10	6.31	5.39	5.11	5.04

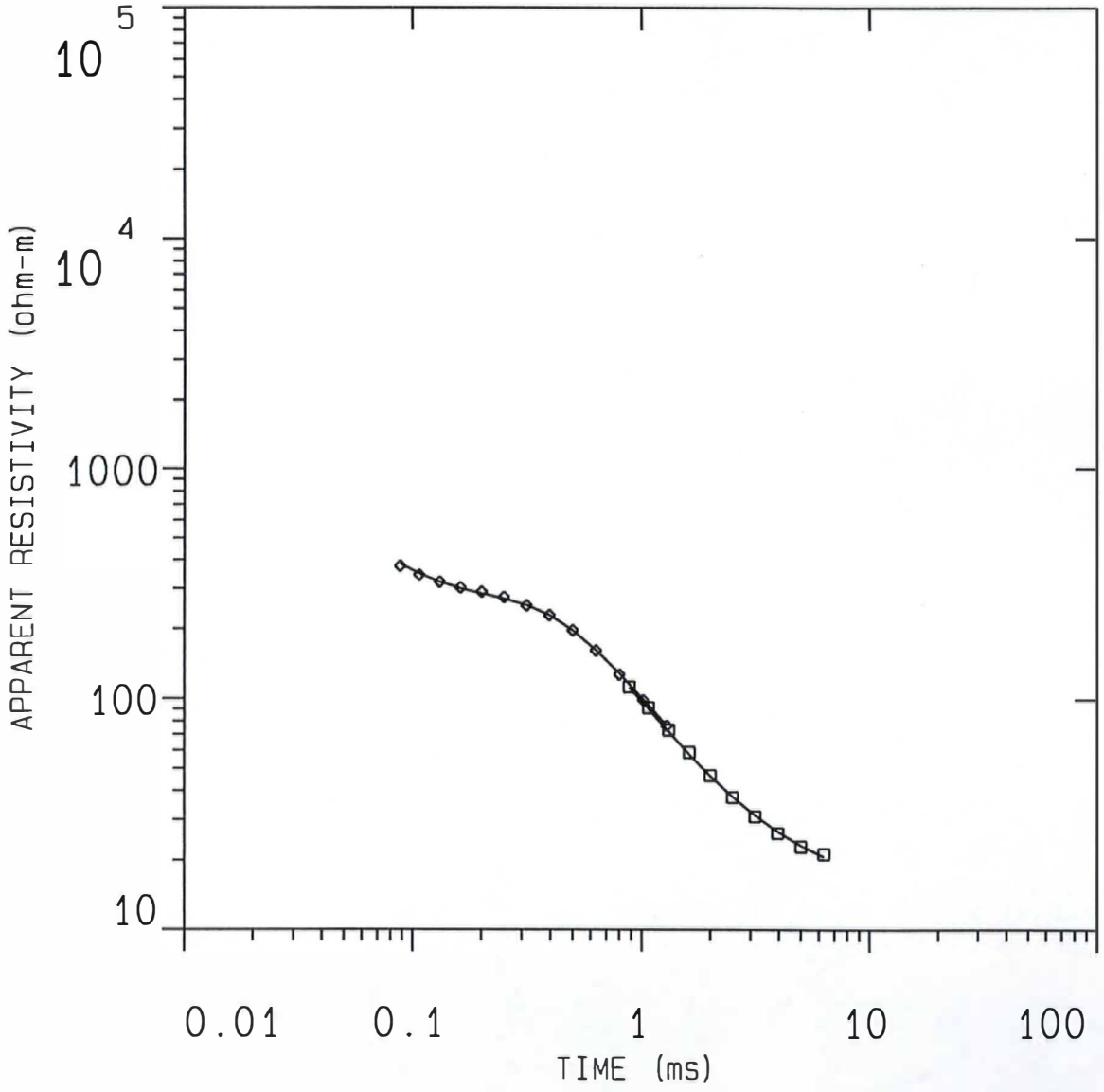
CURRENT: 12.50 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 4 RAMP TIME: 200.00 muSEC

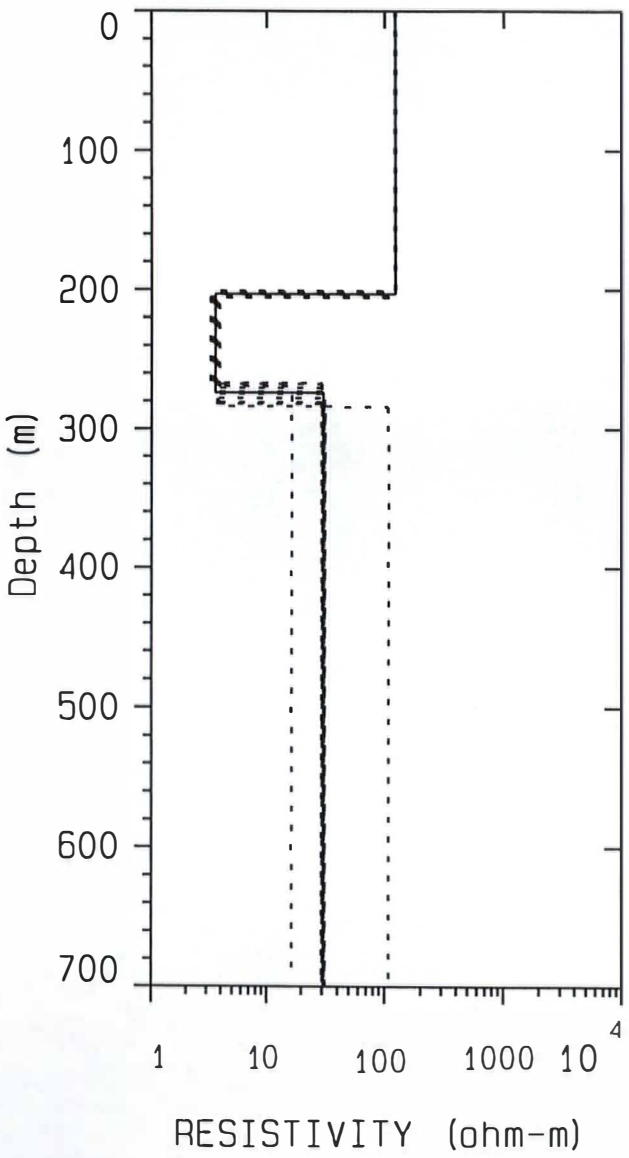
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
11	0.0881	5737.1	5882.0	-2.52
12	0.106	4333.8	4335.9	-0.0480
13	0.131	3140.9	3121.2	0.629
14	0.161	2267.6	2227.4	1.77
15	0.200	1600.3	1568.4	1.99
16	0.250	1092.7	1080.0	1.15
17	0.314	721.0	727.2	-0.859
18	0.395	464.6	478.9	-3.07
19	0.499	300.2	308.8	-2.89
20	0.631	198.9	196.9	1.00
21	0.799	126.9	126.4	0.401
22	1.01	82.84	82.20	0.778
23	1.28	55.38	54.56	1.49
24	1.63	37.12	36.91	0.584

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.99				
P 2	-0.04	0.65			
P 3	-0.01	-0.12	0.81		
T 1	0.03	0.18	0.03	0.89	
T 2	-0.02	-0.12	0.01	0.08	0.92

NKA-5


APPARENT RESISTIVITY (ohm-m)
10^5
10^4
1000
100
10
0.01
0.1
1
10
100
TIME (ms)


Depth (m)
0
100
200
300
400
500
600
700
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

DATA SET: NKA-5

CLIENT: Nani Kahuku Aina, LLC
LOCATION: Floyd Pulham Parcel
COUNTY: Hawaii
PROJECT: Kau District, HI
LOOP SIZE: 305.000 m by 305.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 5.0000 N: 1.0000

DATE: 08-09-08
SOUNDING: 5
ELEVATION: 588.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 1.855 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	(ft)	CONDUCTANCE (Siemens)
			588.0	1930.0	
1	122.6	203.2	384.7	1262.1	1.65
2	3.57	70.61	314.1	1030.5	19.76
3	30.59				

ALL PARAMETERS ARE FREE

PARAMETER BOUNDS FROM EQUIVALENCE ANALYSIS

	LAYER	MINIMUM	BEST	MAXIMUM
RHO	1	121.098	122.654	124.374
	2	3.255	3.572	3.910
	3	16.446	30.592	107.640
THICK	1	200.840	203.259	205.721
	2	61.226	70.612	80.826
DEPTH	1	200.840	203.259	205.721
	2	266.866	273.871	283.726

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 5 RAMP TIME: 150.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)

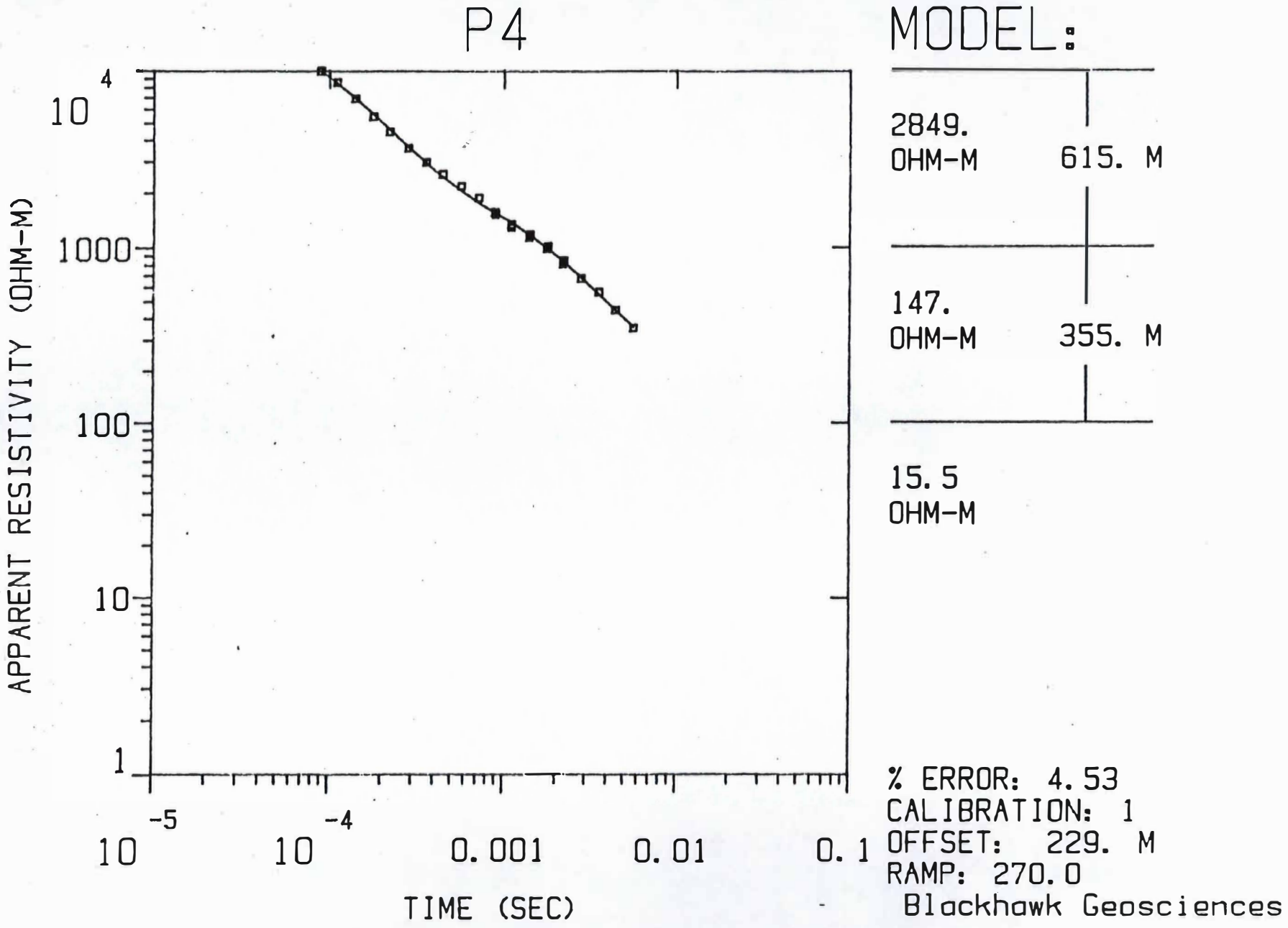
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.881	695.8	701.4	-0.793
2	1.06	586.3	596.9	-1.79
3	1.31	489.7	501.2	-2.35
4	1.61	405.3	416.1	-2.66
5	2.00	335.0	337.2	-0.665
6	2.50	265.9	262.8	1.14
7	3.14	200.3	197.3	1.49
8	3.95	144.9	141.8	2.14
9	4.99	99.16	97.46	1.70
10	6.31	61.55	64.03	-4.03

CURRENT: 13.00 AMPS EM-58 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 3 RAMP TIME: 150.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
11	0.0881	36172.2	34901.5	3.51
12	0.106	25556.5	25059.4	1.94
13	0.131	17026.0	17029.8	-0.0220
14	0.161	11008.4	11133.2	-1.13
15	0.200	6869.7	7037.7	-2.44
16	0.250	4265.8	4350.3	-1.98
17	0.314	2737.1	2721.4	0.573
18	0.395	1782.7	1777.9	0.268
19	0.499	1247.3	1245.9	0.118
20	0.631	937.6	930.8	0.719
21	0.799	740.9	728.6	1.65
22	1.01	598.5	590.3	1.36
23	1.28	483.3	478.5	0.993

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00				
P 2	-0.01	0.88			
P 3	0.00	-0.03	0.02		
T 1	0.00	0.01	-0.01	1.00	
T 2	0.00	-0.16	-0.08	0.03	0.67
	P 1	P 2	P 3	T 1	T 2


P4
MODEL:
2849.
OHM-M
615. M
147.
OHM-M
355. M
15.5
OHM-M
APPARENT RESISTIVITY (OHM-M)
10^4
1000
100
10
1
10^-5
10^-4
0.001
0.01
0.1
TIME (SEC)
% ERROR: 4.53
CALIBRATION: 1
OFFSET: 229. M
RAMP: 270.0
Blackhawk Geosciences

MODEL: 3 LAYER

RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	(FEET)	CONDUCTANCE (S) LAYER	TOTAL
		624.8	2050.0		
2848.93	614.5	10.3	33.8	0.2	0.2
146.63	354.7	-344.4	-1129.6	2.4	2.6
15.52					

	TIMES	DATA	CALC	% ERROR	STD ERR
1	8.90E-05	9.94E+03	9.83E+03	1.101	
2	1.10E-04	8.53E+03	8.44E+03	1.062	
3	1.40E-04	6.88E+03	6.92E+03	-0.653	
4	1.77E-04	5.41E+03	5.59E+03	-3.167	
5	2.20E-04	4.43E+03	4.55E+03	-2.625	
6	2.80E-04	3.57E+03	3.63E+03	-1.556	
7	3.55E-04	2.96E+03	2.93E+03	1.125	
8	4.43E-04	2.54E+03	2.45E+03	3.698	
9	5.64E-04	2.17E+03	2.05E+03	5.751	
10	7.13E-04	1.87E+03	1.75E+03	6.430	
11	8.81E-04	1.56E+03	1.55E+03	0.650	
12	8.90E-04	1.51E+03	1.54E+03	-1.527	
13	1.10E-03	1.33E+03	1.37E+03	-3.090	
14	1.10E-03	1.28E+03	1.37E+03	-6.167	
15	1.40E-03	1.13E+03	1.17E+03	-3.321	
16	1.41E-03	1.17E+03	1.16E+03	0.443	
17	1.77E-03	9.78E+02	9.87E+02	-0.918	
18	1.80E-03	1.00E+03	9.77E+02	2.802	
19	2.20E-03	8.04E+02	8.35E+02	-3.722	
20	2.22E-03	8.42E+02	8.27E+02	1.816	
21	2.80E-03	6.67E+02	6.76E+02	-1.395	
22	3.55E-03	5.60E+02	5.44E+02	2.965	
23	4.43E-03	4.43E+02	4.42E+02	0.092	
24	5.64E-03	3.50E+02	3.54E+02	-1.110	

R: 229. X: 0. Y: 229. DL: 457. REQ: 254. CF: 1.0000
TDHZ ARRAY, 24 DATA POINTS, RAMP: 270.0 MICROSEC, DATA: P4
2903 0004 0004 Z OPR XTL H 6 8+100
Ch.21 = 0.27 Ch.22 = 0.089 Ch.23 = 18.5 Ch.24 =
RMS LOG ERROR: 1.93E-02, ANTILOG YIELDS 4.5350 %
LATE TIME PARAMETERS

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PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER

P 1	0.97				
P 2	-0.04	0.83			
P 3	-0.03	-0.22	0.49		
T 1	0.01	0.02	0.00	1.00	
T 2	-0.02	-0.07	-0.09	0.01	0.96
	P 1	P 2	P 3	T 1	T 2

Table 3-2

GPS Coordinates for TDEM Soundings (UTM meters)

Nani Kahuku Aina, LLC, Hawaii County, Hawaii

Location	ID	UTM (N) m	UTM (E) m	Elev (ft)	Elev (m)	Comments
NKA-1	NKA-1	2109371	217851	1980	603.5	Center of Transmitter Loop
	NE Corner of Loop	2109577	218100			NE Corner of Loop, Along Dirt Road 100 ft South of Hwy 11
NKA-2	NKA-2	2109246	218632	1900	579	Center of Transmitter Loop
	SE Corner of Loop	2109006	218848			SE Corner of Loop, Along Rock Wall in Open Field
NKA-3	NKA-3	2109925	217406	2080	634	Center of Transmitter Loop
	SE Corner of Loop	2109676	217613			SE Corner of Loop, Along Rock Wall 100 ft North of Hwy 11
NKA-4	NKA-4	2109967	216951	2120	646	Center of Transmitter Loop
	SE Corner of Loop	2109718	217157			SE Corner of Loop, Along Rock Wall 100 ft North of Hwy 11
NKA-5	NKA-5	2109601	219275	1930	588	Center of Transmitter Loop
	NE Corner of Loop	2109754	219427	1952	595	NE Corner of Loop, In Pasture, West Side of Water Tank Fence
Well	South Point Road	2109756	219442	1952	595	Junction of Hwy 11 and South Point Road
WT	1952 Water Tank	2109756	219442	1952	595	Junction of Hwy 11 and South Point Road
	Hwy 11 & S. Pt. Rd.	2109778	219469	1952	595	Junction of Hwy 11 and South Point Road
	Hwy 11 & K. Rh. Rd.	2109732	216666	2086	636	Junction of Hwy 11 and Kahuku Ranch Road

APPENDIX C

CD WITH REPORT AND FIGURES

Blackhawk Project Number: 5128

Prepared For:
NANI KAHUKU AINA